

Real-Time Methods for Adaptive Suppression of Adverse Aeroservoelastic Dynamics Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)



ABSTRACT

Adverse aeroservoelastic interaction is a problem on aircraft of all types causing repeated loading, enhanced fatigue, undesirable oscillations and catastrophic flutter. Traditionally, to suppress adverse aeroservoelastic interaction, notch and/or roll off filters are used in the primary flight control system architecture. This solution has pitfalls; rigid body performance is degraded due to resulting phase penalty and it is not robust to off nominal behavior. In Phase I, an approach was developed that is entitled, Modal Isolation and Damping for Adaptive Aeroservoelastic Suppression (MIDAAS). This adaptive technique determines an optimal blend of multiple outputs that effectively isolates a problematic lightly damped mode and simultaneously determines an optimal blend of multiple inputs to suppress the problematic mode via feedback. Adverse effects on aircraft rigid body performance are minimized, resulting in virtually no phase penalty. MIDAAS was validated against aeroservoelastic F/A-18C aircraft models with varying stores configurations and demonstrated very successful performance. In the proposed Phase II program, a robust real-time adaptive aeroservoelastic suppression solution will be developed with a buildup approach that includes further MIDAAS enhancements, extensive validation studies utilizing a high-fidelity CFD-based aeroelastic model of the NASA X-53 aircraft, and extensive validation studies utilizing real-time pilot in the loop simulation capability.

ANTICIPATED BENEFITS

To NASA funded missions:

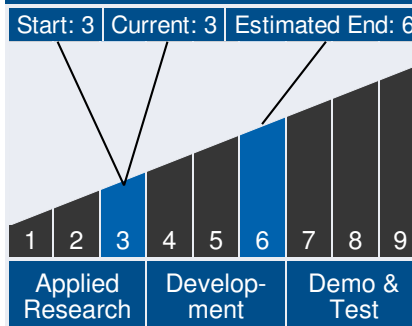
Potential NASA Commercial Applications: Performance degradation due to adverse aeroservoelastic effects is ubiquitous and hence the core methodology can be applied in a variety of areas. Other aerospace applications include rotorcraft systems, rocket booster and spacecraft structural mode detection and control. Outside of aerospace, other areas of



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Technology Maturity



Management Team

Program Executive:

- Joseph Grant

Program Managers:

- Gary Jahns
- Richard Leshner

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application include automotive (for engine and vehicle dynamic monitoring and control), industrial manufacturing (for rejection of machine noise and structural vibrations), infrastructure (for monitoring buildings, bridges, etc., for changes in stiffness and damping and subsequent active suppression of adverse dynamics), and alternative energy (aeroservoelastic suppression for wind turbine technology). Beyond industry there are potential post applications within the US military. Aeroelastic analysis and testing will benefit from the proposed program at military facilities such as the Air Force Flight Test Center at Edwards AFB, the Air Armament Center at Eglin AFB and the Naval Air Warfare Center Weapons Division at China Lake.

To the commercial space industry:

Potential Non-NASA Commercial Applications: NASA is a research leader in the areas of aeroelasticity, flight dynamics, control, and flight testing. The proposed work here naturally follows from and compliments these areas with a specific focus on adaptive suppression of adverse aeroservoelastic phenomena. This program also fits the needs of the NASA Integrated Resilient Aircraft Control (IRAC) project by supplying a robust adaptive solution to controlling adverse conditions in the presence of off nominal system variations. Safe flight is further ensured by the comprehensive validation approach that includes real-time piloted simulations. NASA aeronautics centers (DFRC, LaRC, ARC) have the most potential benefit but the program may also be beneficial to NASA space programs (i.e., suppression of high frequency resonance in spacecraft and rocket systems). The proposed program will lead to a commercial software and hardware simulation product targeted at aeroservoelastic aircraft systems providing a valuable asset for many NASA programs.

Management Team (cont.)

Project Managers:

- Martin Brenner
- Gary Jahns

Principal Investigators:

- Brian Danowsky
- Cecy Pelz

Technology Areas

Primary Technology Area:

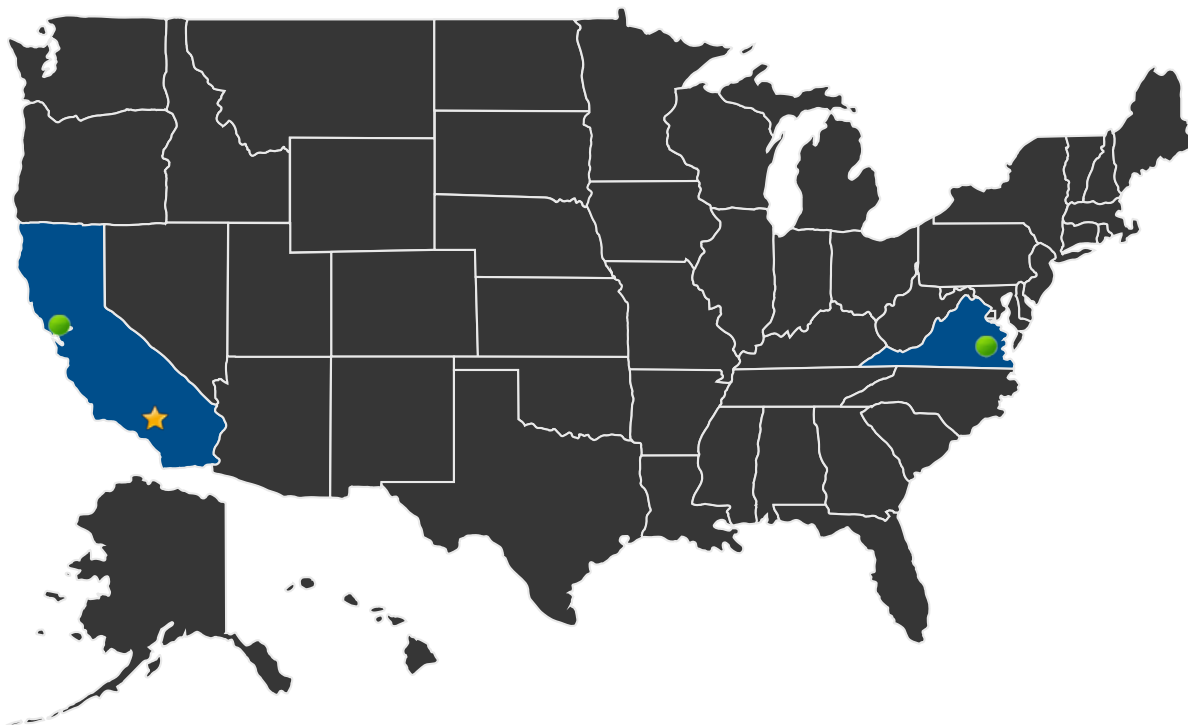
Aeronautics (TA 15)

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U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States With Work

★ **Lead Center:**
Dryden Flight Research Center

● **Supporting Centers:**

- Ames Research Center
- Langley Research Center

Other Organizations Performing Work:

- Systems Technology, Inc. (Hawthorne, CA)

Active Project (2011 - 2016)

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DETAILS FOR TECHNOLOGY 1

Technology Title

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